English translation of Amendments
under PCT Article 34

environment, following the motion of the object as smoothly as possible and also optimizing the image quality at that moment.

Disclosure of the Invention

In order to solve these problems, the image processing device of the present invention is an image processing device provided with a first image-taking mode used when it is bright around and a second image-taking mode used when it is dark around, comprising a lens unit which forms an optical image of an object on an imaging element; an iris which adjusts a light quantity which has entered said lens unit; an imaging element having an electronic shutter function of outputting the optical image of the object for which the light quantity from said iris is adjusted as an image signal; an AGC amplifier which amplifies an image/video signal from said imaging element and can adjust an amplification gain thereof; signal processing means for obtaining a video signal by subjecting the image signal amplified by said AGC amplifier to signal processing; comparison means for comparing the brightness signal level of said video signal indicating the brightness of the object with a predetermined reference brightness signal level; and imaging control means, wherein in said second image-taking mode, said imaging control means changes the length of period of said electronic shutter function for every period of a multiple of two fields, continuously changes the electronic shutter-ON time (exposure time) in accordance with the period and holds the electronic shutter-ON time at a time point at which the output of said comparison means at which said brightness signal level matches said reference brightness signal level becomes 0 (zero).

The image processing device according to the present invention is an image processing device which enables image taking in a dark environment by setting an electronic shutter-ON time which is an exposure time of an imaging element to an $m \cdot Tf$ (m: positive number) period within a period $M \cdot Tf$ (M: 1 and

even number of 2 or greater, Tf: 1-field period), comprising an imaging element made up of an imaging surface consisting of photoelectrical conversion elements for converting light to charge, an accumulation section for accumulating the charge generated from the photoelectrical conversion element and a charge transfer element (Charge-Coupled Device) for transferring the accumulated charge in vertical and horizontal directions and obtaining an image signal, the imaging element

in the accumulation section 4 in vertical and horizontal directions and obtains an image signal. Reference numeral 6 denotes an imaging element made up of the PD 3, accumulation section 4 and CCD 5. Reference numeral 21 denotes an imaging element driver which controls and drives the imaging element 6 to extract an image signal from the imaging element 6. Reference numeral 18 denotes imaging element control means for generating timing signals to set the above described electronic shutter-ON time (exposure time) for the imaging element driver 21 and extract accumulated image signals.

Reference 7 denotes an amplifier composed of a CDS circuit which reduces noise of the image signal obtained from the imaging element 6 and an AGC circuit.

Reference numeral 16 denotes AGC gain control means for setting a gain of the AGC circuit of the amplifier 7.

An A/D converter 8 converts the image signal obtained from the amplifier 7 to a digital signal. A signal processing circuit 9 converts the digital image signal obtained from the A/D converter 8 to a digital standard video signal made up of a brightness signal and color signal.

Here, a normal image-taking mode (first image-taking mode) and a high-sensitivity image-taking mode (second image-taking mode) will be explained.

The normal image-taking mode referred to here is a normal image taking state within a range in which it is bright around, no illumination is required and an image captured can be normally judged. In this mode, as described above, the electronic shutter time (exposure time) is set by the imaging element control means 18 to 1/fv (fv: field frequency of video signal) sec (approximately 1/60 sec) which is a 1/fv period of the video signal. Therefore, the field period (Tf) coincides with the electronic shutter time (exposure time) in the normal image-taking mode, and therefore normal moving image taking can be performed. On the other hand, in the high-sensitivity image-taking mode according to the present invention, effective

In a video camera, an image consists of frame units each frame made up of odd and even fields of a video signal. Since the electronic shutter-ON time (hereinafter also referred to as "exposure time") corresponds to a period during which charge from the PD 3 is accumulated in the accumulation section 4, and therefore setting the exposure time to a time exceeding a 1-field period requires periodic signal processing in units of several frames including the exposure time.

In the case of the high-sensitivity image-taking mode, the imaging element driver 21 which drives and controls the accumulation section 4 and CCD 5 of the imaging element 6 is supplied with control signals shown in FIGS. 2(a), (b), (c) from the imaging element control means 18 via signal lines 47, 46, 44. (FIGS. 2(a), (b), (c) correspond to (a), (b), (c) shown in signal lines 47, 46, 44 in FIG. 1).

A first control signal (a) in FIG. 2 is a signal for specifying an exposure time (charge accumulation period) and a discharge period and is a control signal indicating an exposure time $Texp = m \cdot Tf$ which corresponds to a period during which the charge from the PD 3 is accumulated in the accumulation section 4 and an electronic shutter OFF-time $Tdis = n \cdot Tf$ which corresponds to a period during which the charge from the PD 3 is discharged and no charge is accumulated in the accumulation section 4. Texp and Tdis are designed to have the following relationship so that an electronic shutter operation is performed periodically.

$$Tall = Texp + Tdis$$
$$= m \cdot Tf + n \cdot Tf$$
$$= (m+n)Tf = M \cdot Tf \qquad \ldots(1)$$

$$m+n = M \qquad \ldots(2)$$

where Tf = 1-field period, m: a positive number of 1 to 34, n: positive number of 0 to 2, M: 1 and even number of 2 to 34 or so and the relationship between m and M is expressed by the following expression:

$M = 1$ when $m = 1$

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where ks is a constant. Since the light quantity is energy, Expression (4) can be expressed by a multiple-order function of Yd, yet it is complicated, and so it is expressed by a first-order expression.

Reference numeral 30 is first judging means for judging the sign of the error signal Yd, judging the 0 (zero) value and generating a control signal. In other words:

error signal Yd = brightness signal component value Y - brightness signal Ys

and therefore the first judging means is the means for generating respective control signals by making the following decisions:

When Y>Ys, positive (+)

When Y = Ys, 0

When Y<Ys, negative (-)

As shown in FIG. 4, first switching means 32 changes the destination of the above described exposure time correction value Δm·Tf according to a control signal from the first judging means 30. Reference numeral 33 denotes first subtraction means and 34 denotes first addition means.

Exposure time (electronic shutter-ON time) calculation processing means 45 comprises the first judging means 30, the exposure correction value calculation means 31, first switching means 32, addition means 34 and subtraction means 33.

Exposure memory means 35 accumulates the value of the exposure time m·Tf obtained through a calculation by the exposure time calculation means 45 and the value of the period M·Tf calculated from Expressions (1), (2) and (3) above based on this exposure time m·Tf until the next period.

As shown in FIG. 2, the exposure time m1·Tf in the next period is calculated by the exposure time calculation means 45 in the current period (M0·Tf period) and the exposure time m1·Tf (= exposure time m-1·Tf in the preceding period ± exposure time correction value Δm-1·Tf) in the next period is obtained. (The calculation period corresponds to the section indicated by reference numeral 114 shown in FIG. 2(c)). In this way,

the value of the exposure time m-1·Tf in the preceding period (M-1·Tf) is delayed up to the current period (M0·Tf) by the exposure memory means 35, and the exposure time m1·Tf in the next period calculated in the current period (M0·Tf) and M1·Tf in the next period are obtained for every two periods and accumulated in memory. Reference numeral 38 denotes control signal generating means for generating the control signals shown in FIGS. 2(a), (b) and (c) given to the imaging element driver 21 from the values of the exposure time m·Tf and the period M·Tf for every two periods obtained from the exposure memory means 35.

As described above, when Y>Ys, a positive control signal for switching the first switching means 32 is supplied from the first judging means 30 through the first switching means 32, and therefore the above described exposure time correction value Δm·Tf is supplied to a subtraction (-) input of the subtraction means 33 via a terminal b(+). The value of an exposure time m-1·Tf of the current period M0·Tf in the preceding period M-1·Tf shown in FIG. 2(a) is supplied to an addition (+) input of the subtraction means 33 from the exposure memory means 35 and an exposure time corresponding to the next period expressed by the following Expression is obtained from the subtraction means 33.

$$m1 \cdot Tf = m{-}1 \cdot Tf - \Delta m{-}1 \cdot Tf \qquad \ldots (5)$$

Y>Ys means that the brightness signal component value obtained by the exposure time m-1·Tf in the preceding period M-1·Tf is greater than a reference value, that is, the exposure time in the preceding period is long, and therefore if the next period is shortened, Y approximates to Y = Ys.

The exposure time m1·Tf in the next period calculated by Expression (5) is shorter than the exposure time m-1·Tf in the preceding period by the exposure time correction value Δm-1·Tf in the preceding period calculated by Expression (4) above. These relational Expressions are also shown in FIG. 4.

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On the other hand, when $Y<Ys$, the first switching means is changed to a terminal a(-), and therefore $\Delta m \cdot Tf$ is supplied to one addition input of the addition means 34. The value of

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the exposure time $m-1 \cdot Tf$ in the above described preceding period $M-1 \cdot Tf$ is supplied to the other addition input and the exposure time corresponding to the next period expressed by the following expression is obtained from the addition means 34.

$$m1 \cdot Tf = m-1 \cdot Tf + \Delta m-1 \cdot Tf \quad \ldots (6)$$

$Y<Ys$ means that the brightness signal component value obtained for the exposure time $m-1 \cdot Tf$ in the preceding period $M-1 \cdot Tf$ is smaller than the reference value, that is, the exposure time in the preceding period is short, and therefore if the exposure time in the next period is extended, Y approximates to $Y = Ys$.

The exposure time $m1 \cdot Tf$ in the next period calculated according to Expression (6) is longer than the exposure time $m-1 \cdot Tf$ in the preceding period by the exposure time correction value $\Delta m-1 \cdot Tf$ in the preceding period calculated according to Expression (4) above. These relational Expressions are also shown in FIG. 4.

FIG. 9 is a graph showing the above described control system in a relationship between the brightness of an object and exposure time. The horizontal axis shows the brightness (illuminance) of the object. The brightness detected here is an incoming light quantity and shows from a state in which the iris is maximum, that is, opened to the full, the brightest (position of dotted line 130) to a dark state (position of dotted line 142). The vertical axis shows the exposure time $m \cdot Tf$ and period $M \cdot Tf$ to be set corresponding to the brightness of the object and also shows an iris value I and AGC gain value G in the iris control. As shown in the figure, there are four control areas according to the brightness. ALC 120 has the same range as that in the above described normal image-taking mode and the exposure time is fixed to a 1-field period length 1 Tf (1/fv) as indicated by reference numeral 124a. Only the iris is controlled. The iris value I is expressed by an aperture diameter. If this is expressed with an F value, the stop is closed (the aperture diameter is a minimum value) when it is

This value can be approximately estimated from FIG. 10. Ys having the same value as Ya is a point 129c, which is the intersection between the curve shown by a dotted line 145 (this dotted line is the solid line 127b turned upside down and passes through the point at 129a) and the curve shown by reference numeral 127b. Suppose this point Ys is Ysc. A dotted line 146 which passes through this point has an exposure time of 14.5 Tf (close to 14 Tf indicated by a dotted line 136). From these:

$$\Delta m\text{-}1 \cdot Tf = 26.5Tf - 14.5Tf = 12Tf$$

In practice, this is calculated according to Expression (8). $\Delta m\text{-}1 \cdot Tf$ is obtained from a correlation by multiplying the difference between Y and Ys by a correction coefficient ks. The exposure time $m1 \cdot Tf$ in the next period $M1 \cdot Tf$ is calculated from Expression (5) as:

$$\begin{aligned} m1 \cdot Tf &= m\text{-}1 \cdot Tf - \Delta m\text{-}1 \cdot Tf \\ &= 26.5Tf - 12Tf \\ &= 14.5Tf \end{aligned}$$

In the next period, Y substantially matches Ys, and therefore if it is accumulated in the exposure memory means 35 for that exposure time, 14.5 Tf in this case, it is possible to realize image taking under an exposure condition that matches the brightness. Detecting a match between Y and Ys equals detecting that Yd is 0. This detection is performed by the first judging means 30. If Yd = 0, that is, Y = Ys = Ysc, a control signal is supplied from the first judging means 30 to the exposure memory means 35, and in subsequent periods, the exposure time accumulated at that time point is held. The area of STC 121 is controlled as shown above. Next, control over the area of ALC 120 having a brighter object illuminance than the area of STC 121 will be explained.

The control in this area is performed by the iris control means 19 in FIG. 1. The exposure time in this area is 1-field period 1 Tf (= 1/fv) as described above. FIG. 5 is a detailed block diagram of the iris control means 19. An error signal

the reference value Ys of the brightness signal component (in this area, Ys = Yh (constant) as shown in FIG. 10). Based on the error signal Yd, an iris correction value ΔI-1 in the preceding period (field) shown by Expression (9) is calculated using the iris correction means 50. In the current period (field), depending on whether the Yd is positive or negative, an addition or subtraction is performed between the iris value I-1 in the preceding period (field) obtained from the iris value memory means 55 and above described iris correction value ΔI-1 by the second addition means 54 or second subtraction means 53 and an iris value I1 for the next period is calculated. 2-field cycle control is performed in such a way that the iris value I1 obtained is executed in the next period and an iris value I when Y = Ys(Yh), that is, Yd = 0 is held. Yd = 0 is judged by the second judging means 52. When Yd = 0, a control signal is supplied from the second judging means 52 to the iris value memory means 55 and the iris value at that time point is accumulated in memory and held, and therefore an optimum iris value corresponding to the brightness is set and optimum image taking can be realized. This is the method of controlling the area of ALC 120. Next, control over the area of IRIS 122 having an object illuminance darker than the area of STC 121 will be explained.

This area is controlled by the iris control means 19 in the same way as the area of ALC 120. The operation of the iris control means 19 in this area is basically the same as the above described area of ALC 120, but it differs in the control cycle, that is, exposure time m·Tf (= period M·Tf) and reference value Ys of the brightness signal component. A comparison is shown below (see FIG. 9 and FIG. 10).

	M·Tf (= period M·Tf)	Reference value Ys of brightness signal component
ALC	1Tf (constant)	Yh
IRIS	Maximum value (34Tf) (constant)	Yl

the gain values to the amplifier including the AGC circuit and generating a control signal for setting the gain of the AGC circuit.

The calculation processing by the gain calculation means 78 will be performed as follows. Reference numeral 70 is AGC gain correction value calculation means for performing a calculation shown in the following expression based on the error signal Yd in the preceding period.

$$\Delta G = Yd \cdot kg \quad \ldots (10)$$

where ΔG: gain correction value, kg: gain correction coefficient (constant).

Third judging means 72 judges the sign of the error signal Yd, judges the value of 0 (zero) and generates a control signal. The error signal Yd = brightness signal component value Y - reference value of brightness signal component Ys, and therefore this is the means for generating respective control signals by making the following decisions:

When Y>Ys, positive (+)

When Y = Ys, 0

When Y<Ys, negative (-)

Reference numeral 71 denotes third switching means for switching the destination of the above described gain correction value ΔG and is switched according to a control signal from the third judging means 72 as shown in FIG. 6. Reference numeral 73 is third subtraction means and reference numeral 74 denotes third addition means.

In this case, the brightness signal component value Y corresponding to the input light quantity accumulated in the preceding period is detected and compared with the reference value Ys of the brightness signal component (in this area, Ys = Y1 (constant) as shown in FIG. 10). Based on the error signal Yd, the gain correction value means 70 calculates a gain correction value ΔG-1 in the preceding period shown by Expression (10). In the current period, depending on whether the Yd is positive or negative, an addition or subtraction

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is performed between the gain value G-1 in the preceding period obtained from the AGC gain value memory means 75 and above described gain correction value ΔG-1 by the third addition means 74 or third subtraction means 73 and a gain value G1 for the next period is calculated. 2-period cycle control is performed in such a way that the gain value G1 obtained is executed in the next period and a gain value G when Y = Ys(Y1), that is, Yd = 0 is held. Yd = 0 is judged by the third judging means 72. When Yd = 0, a control signal is supplied from the third judging means 72 to the gain value memory means 75 and the gain value at that time point is accumulated in memory and held, and therefore an optimum gain value corresponding to the brightness is set and optimum image taking can be realized. This is the control method in the AGC area.

In this way, the control over four areas has been explained individually and it is an object of the present invention to set an optimum exposure time, iris value and AGC gain value in accordance with the brightness of the object in order to realize effective image taking in a dark environment. That is, when a situation is changed from a state in which image taking is performed in a normal image-taking mode to image taking in a dark environment, it is an object of the present invention to change the mode to the above described high-sensitivity image-taking mode, obtain the exposure time, iris value, AGC gain value (hereinafter referred to as "3 optimum set values") under an optimum condition which matches the brightness in the above described four areas and maintain their values. For that purpose, a method of obtaining three optimum set values which match the brightness so as to automatically sweep the above described four areas will be explained.

The selection signal generating means 17 in FIG. 1 generates control signals to switch the imaging element control means 18, iris control means 19 and AGC gain control means 16 in order to automatically sweep the above described four areas.

FIG. 7 is a block diagram thereof and FIG. 8 shows time charts of signals on the respective signal lines.

Reference numerals 93, 95, 96 in FIG. 7 denote OR gates, 94, 97 denote flip flops, 98 denotes a NOR gate. The operation of the selection signal generating means 17 including these circuits will be explained below.

First, when the image taking condition is changed from a normal image-taking mode to a high-sensitivity image-taking mode (the mode switching button 12 is pressed for this switching as described above), the mode signal generating means 13 supplies a start signal shown in FIG. 8(a) to the selection signal generating means 17 via a signal line 99. At the same time, the mode signal generating means 13 supplies initial values at the control start to the exposure memory means 35 in the imaging element control means 18, iris value memory means 55 in the iris control means 19 and AGC gain value memory means 75 in the AGC gain control means 16 respectively. These initial values are prestored in the data table or the like in the mode signal generating means 13.

As shown at the control start point in FIG. 9, a maximum value (34 Tf) is supplied to the exposure memory means 35 as the initial value of the exposure time, Imax (Fmin) is supplied to the iris value memory means 55 and a maximum value (Gmax) is supplied to the AGC gain value memory means 75 and stored in the respective memories. This is done because it is unknown in which area of the above described four areas the brightness of the object is located, and so the control is started from the darkest state when the image-taking mode is switched to the high-sensitivity image-taking mode. This start signal passes through the OR gate 93 and is supplied to S (set input) of the flip flop 94. Therefore, a control signal G is obtained at the output Q of the flip flop 94 as indicated in FIG. 8(h) which rises the moment the start signal enters. This control signal G is supplied to the AGC gain control means 16 via a signal line 92. This control signal G is supplied to the AGC

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The turning point at which the area of AGC is switched to the area of IRIS can be found by detecting a time point at which the AGC gain value becomes a minimum value (0 dB) as shown in FIG. 9. Reference numeral 76 in FIG. 6 denotes minimum gain judging means, which generates a control signal for surpassing the area of AGC and entering the control area of the area of IRIS. According to the control method in the AGC area, control is performed such that an optimum value of the AGC gain value is calculated in the period of the exposure time maximum value (34 Tf) as described above, and therefore control is performed in a direction in which the gain value is reduced. Even when the gain is reduced, Y>Ys, and therefore after several control cycles, a time point appears at which the AGC gain value from the third subtraction means 73 in the AGC gain control means 16 becomes a minimum value. The minimum gain judging means 76 detects the time point at which the minimum value is reached and generates a gain minimum value arrival signal as shown in FIG. 8(b). This signal is supplied to a reset input R of the flip flop 94 and OR gate 95 of the selection signal generating means 17 shown in FIG. 7 via a signal line 80. Therefore, the flip flop 94 is reset and the control signal G shown in FIG. 8(h) is obtained at the output Q, and when this signal becomes L level, the control by the AGC gain control means 16 is stopped and as described above, the gain minimum value stored in the AGC gain value memory means 75 is supplied to the amplifier 7 including the AGC circuit from this time point onward. This gain minimum value arrival signal is passed through the OR gate 95 and also supplied to the set input S of the flip flop 97, and therefore a control signal I shown in FIG. 8(i) is obtained at the output Q of the flip flop 97. This control signal I is supplied via a signal line 91 to the iris value memory means 55 and iris correction value calculation means 50 in the iris control means 19. For a period during which this control signal I is at H level, these means operate, and as will be described hereinbelow, the iris correction value

ΔI as the output of the iris correction value calculation means 50 is held to a zero value for a period during which this control signal I is at L level and the iris value memory means 55 holds the final memory value Ist (Fr. S) at the end of the operation. That is, the AGC gain value memory means 55 holds the memory value at the time that the control signal I changes from the H level to L level. In this way, the period during which the control signal I is at H level corresponds to the period during which the iris control means 19 is operating.

During this operation period, if the brightness of the object is at some position in the IRIS area, there is a time point at which the value of the above described error signal Yd becomes 0 and an iris value Ix at that time point is stored and held by the iris value memory means 55. That is, for the three optimum set values at this time point, the exposure time becomes a maximum value (34 Tf), the iris is Ix, the AGC gain becomes a minimum value (0 dB) and the imaging element 6, iris 2 and amplifier 7 operate with these values.

While these values are held, the above described control signal I (see FIG. 8(i)) is held at H level, which means that the iris control means 19 is operating (the set value is determined at some position in section B in the time chart shown in FIG. 8).

Next, when the brightness of the object is in the STC area (see FIG. 9 and FIG. 10) 121, the control is started by pressing the mode switching button 12, the start signal and initial value are set as shown above, but since the error signal Yd (= Y-Ys) obtained from the comparison means 15 is Yd>0, that is, Y>Ys in the AGC area 123 and IRIS area 122, and therefore these areas are passed. At a turning point at which the AGC area 123 is surpassed and the IRIS area 122 is switched to the STC area 121, a point at which the iris value becomes Ist (Fr.s) (point b) as shown in FIG. 9 may be detected. The first iris value judging means 57 in FIG. 5 is intended to detect a point at which the iris value becomes Ist (Fr.s) (point b).

value (minimum value) at the end of the operation. That is, the exposure memory means 35 holds the memory value at a time point at which the control signal P is changed from H level to L level. The period during which the control signal P is at H level corresponds to a period during which the imaging element control means 18 is operating.

During this operation period, if the brightness of the object is at some position in the STC area, there is a time point at which the value of the above described error signal Yd becomes zero and the exposure time mxTf at that time point is held in the exposure memory means 35. That is, for the three optimum set values at this time point, the exposure time is mxTf, the iris value is Ist(Fr.s), the AGC gain becomes a minimum value (0 dB) and the imaging element 6, iris 2 and amplifier 7 operate with these values. While these values are held, the above described control signal P (see FIG. 8(j)) is held at H level. This means that the imaging element control means 18 is operating (the set value is determined at some position in a section C of the time chart shown in FIG. 8).

Next, when the brightness of the object is in the ALC area (see FIG. 9 and FIG. 10) 120, the control is started by pressing the mode switching button 12, the start signal and initial value are set as shown above, but since the error signal Yd (= Y-Ys) obtained from the comparison means 15 is Yd>0, that is, Y>Ys in the AGC area 123, IRIS area 122 and STC area 121, and therefore these areas are passed through the control of the control areas. At a turning point at which the AGC area 123 and IRIS area 122 are surpassed and the STC area 121 is switched to the ALC area 120, a point at which the exposure time becomes a minimum value (1 Tf) may be detected as shown in FIG. 9. The minimum exposure judging means 36 in FIG. 4 is the exposure time minimum value (1 Tf) judging means for generating a control signal for surpassing the STC area 121 and switching to the control area of the ALC area 120. According to the control method in the STC area 121, control is performed

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judging means 56, the control signal obtained is supplied to the iris value memory means 55 and the iris value memory means 55 stores and holds this Imin.

As shown above, no matter in which area of ALC, STC, IRIS, AGC the brightness (illuminance) of the object is located, an optimum exposure time, iris value and AGC gain value which match the brightness are calculated, the values are stored in memory and held, and image taking is performed under an optimum condition.

However, when image taking is realized in the high-sensitivity image-taking mode and under an optimum condition, if the brightness around changes suddenly or when the place of image taking is changed from indoors to outdoors, or vice versa, the brightness of the object changes.

When the brightness around is brighter than the brightness with the three optimum set values which are currently set in memory, if control of the change from the above described dark state to bright state, that is, a calculation of subtracting a correction value from the value one cycle ahead through the subtraction means of each control means in each control area is performed, the three optimum set values under the changed and brighter condition are obtained.

On the contrary, if control of the change from the above described bright state to dark state, that is, a calculation of adding a correction value to the value one cycle ahead through the addition means of each control means in each control area is performed, the three optimum set values under the changed and darker condition are obtained.

When the set value is stored in memory and the imaging element 6, iris 2 and amplifier 7 are operated under that new image taking condition, it is possible to realize optimum image taking in the new environment.

reaches the above described Ist (point a). When the iris value obtained from the second addition means 54 reaches Ist, the second iris value judging means 59 obtains an iris value Ist (point a) arrival signal shown in FIG. 8(e). This signal is supplied to the OR gate 96 in selection signal generating means 17 via a signal line 63. This signal passes through the OR gate 96 and is supplied to the reset input R of the flip flop 97, and therefore the flip flop 97 is reset and the control signal I shown in FIG. 8(i) is obtained at the output Q. When the iris value Ist (point a) arrival signal shown in FIG. 8(e) is supplied to the selection signal generating means 17, the operation of the iris control means 19 is stopped (section D in FIG. 8 ends) and the iris value memory means 55 holds the above described iris value Ist. On the other hand, the control signal P shown in FIG. 8(j) is obtained from the NOR gate 98 of the selection signal generating means 17 and this signal is supplied to the imaging element control means 18. Therefore, the STC area, that is, the control (section E in FIG. 8) by the imaging element control means 18 starts from the time point at which the above described arrival signal is issued. Assuming that the brightness is located at some position in the STC area, control is performed such that the exposure time m·Tf is increased until the exposure time that matches the brightness is obtained. As described above, when the control enters the STC area 121, the exposure time starts from 1 Tf as shown in FIG. 10 (position of dotted line 131). For example, if the brightness of the current object is assumed to be at the position of the dotted line 146, the brightness signal component value Y at the position of the dotted line 131 becomes the value of Yb shown by reference numeral 148. Furthermore, reference numeral 147 denotes a reference value Yso of the brightness signal component at this position and Yso = Yh. The error signal Yd at this position is $Y = Yb < Ys = Yso = Yh$, and therefore $Yd\ (= Y - Ys) < 0$, and the exposure time

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In this case, since Y<Ys in the STC area 121, the exposure time increases and reaches a maximum value. A dotted line 140 in FIG. 10 denotes the position of brightness of the maximum exposure time value and indicates a boundary position at which the STC area 121 transitions to the IRIS area 122.

Maximum exposure judging means 37 in the imaging element control means 18 in FIG. 4 detects a time point at which the exposure time periodically obtained from the first addition means 34 reaches a maximum value (34 Tf) and generates a control signal at that time point. An exposure time maximum value arrival signal shown in FIG. 8(f) is obtained from the maximum exposure judging means 37 and supplied to the OR gate 95 of the selection signal generating means 17 shown in FIG. 7 via a signal line 43. This signal passes through the OR gate 95 and is added to the set input S of the flip flop 97, and therefore a control signal I as shown in FIG. 8(i) is obtained at the output Q. As described above, this signal is added to the iris control means 19, and therefore the control by the iris control means 19 starts from the time point at which the above described arrival signal is generated. The control of a section F in FIG. 8 is performed. The method of obtaining an optimum set value by the iris control means 19 is the same as that explained so far.

When the object is placed in the dark AGC area 123, the time point at which the iris value reaches a maximum value (position indicated by a dotted line 141 in FIG. 10) is detected and the AGC gain control means 16 may be operated from that time point. The maximum iris value judging means 58 of the iris control means 19 in FIG. 5 detects the time point at which the iris value obtained from the second addition means 54 reaches a maximum value. An iris maximum value arrival signal shown in FIG. 8(g) is obtained from the maximum iris value judging means 58. This signal is supplied to the OR gate 93 of the selection signal generating means 17 shown in FIG. 7 via the signal line 62. Since this signal is passed through the OR

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CLAIMS

1. (Amended) An image processing device provided with a first image-taking mode used in a bright environment and a second image-taking mode used in a dark environment, comprising:

a lens unit which forms an optical image of an object on an imaging element;

an iris which adjusts a light quantity which has entered said lens unit;

an imaging element having an electronic shutter function of outputting the optical image of the object for which the light quantity from said iris is adjusted as an image signal;

an AGC amplifier which amplifies an image/video signal from said imaging element and can adjust an amplification gain thereof;

signal processing means for obtaining a video signal by subjecting the image signal amplified by said AGC amplifier to signal processing;

comparison means for comparing the brightness signal level of said video signal indicating the brightness of the object with a predetermined reference brightness signal level; and

imaging control means,

wherein in said second image-taking mode, said imaging control means changes the length of period of said electronic shutter function for every period of a multiple of two fields, continuously changes the electronic shutter-ON time (exposure time) in accordance with the period and holds the electronic shutter-ON time at a time point at which the output of said comparison means at which said brightness signal level matches said reference brightness signal level becomes 0 (zero).

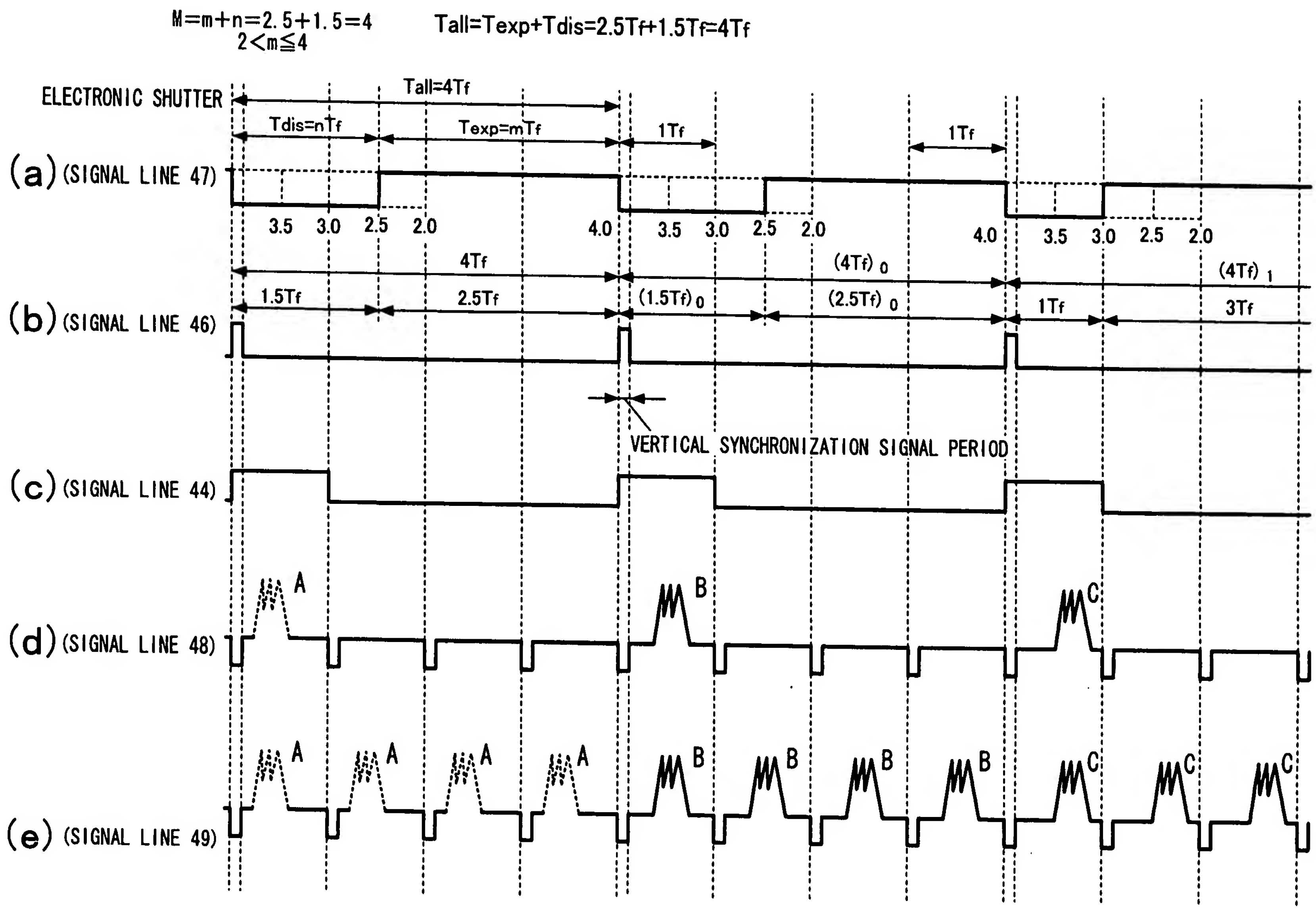
2. (Amended) The image processing device according to claim 1, wherein the imaging control means comprises iris control means for adjusting said iris when the brightness around is brighter than a predetermined value and darker than a

predetermined value and holding the iris when the output of the comparison means at which the brightness signal level matches the reference brightness signal level becomes 0 (zero).

3. (Amended) The image processing device according to claim 1, wherein the imaging control means comprises gain control means for adjusting the gain of the AGC amplifier when the brightness around is darker than a predetermined value and holding the gain value when the output of said comparison means at which said brightness signal level matches said reference brightness signal level becomes 0 (zero).

4. An image processing device which forms an automatic search control loop whose period consists of M·Tf (= m·Tf+n·Tf, M: 1

FIG.3



AMENDED SHEET

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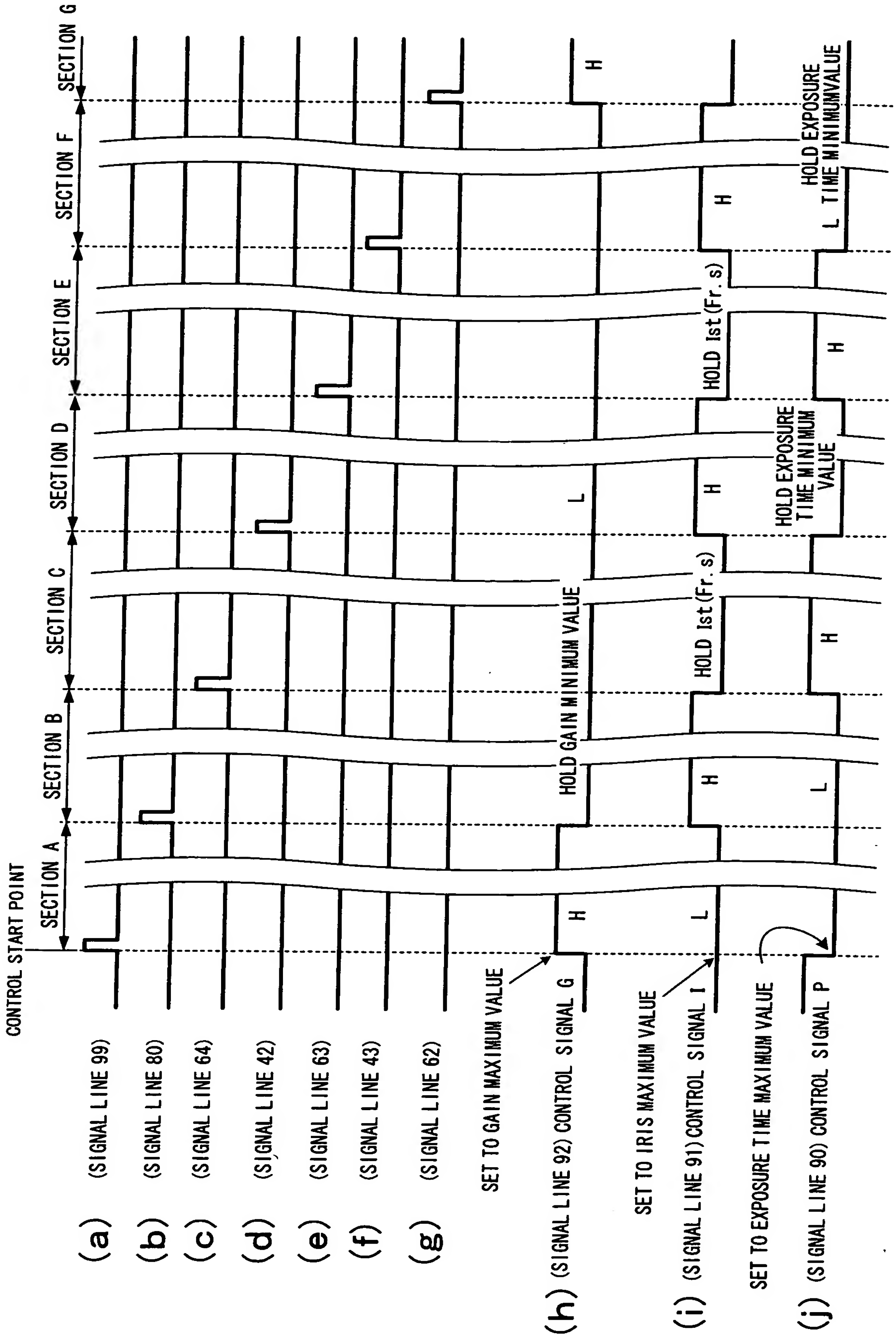

FIG. 8